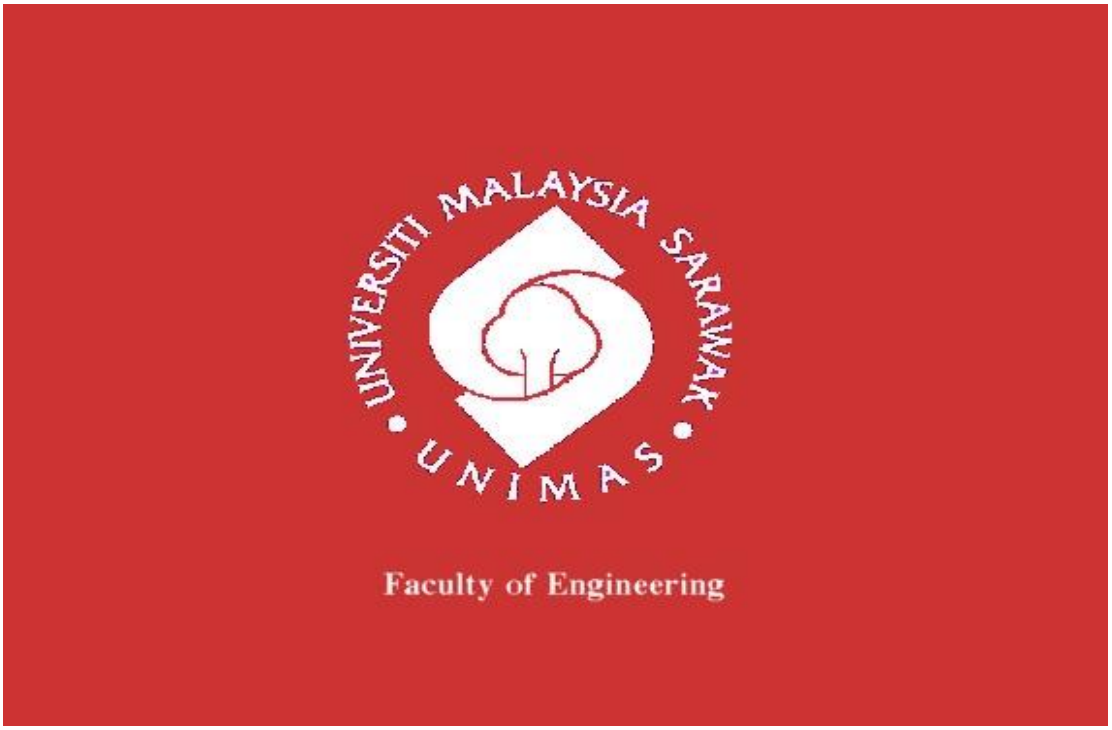

ORGANIC SOIL STABILIZATION BY DIFFERENT TYPES OF ADMIXTURES

NOOR SURAYA BINTI ROMALI

Bachelor of Engineering with Honors
(Civil Engineering)
2006

Universiti Malaysia Sarawak
Kota Samarahan

Fk

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Judul: **Organic Soil Stabilization By Different Types Of Admixtures**

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Author's Name	:	Noor Suraya Binti Romali
Matrix No.	:	8783

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Dr. Prabir Kumar Kolay Date

ORGANIC SOIL STABILIZATION BY DIFFERENT TYPES OF ADMIXTURES

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This thesis is submitted in partial of fulfillment of the requirements for the
Degree of Bachelor of Engineering with Honors
(Civil Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2006

To my beloved parents, family, lecturers and friends.

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ABSTRACT

Organic soil, mainly peat, becomes the major problem in the infrastructural expansion in coastal areas especially in Sarawak, Malaysia. In order to bring the coastal regions of Sarawak into the mainstream of development, a good network of infrastructure is required to facilitate any expansion program. Constructing infrastructure along the coastal areas however is not an easy task, as these areas are covered by corridors of organic soils mainly peat deposits. Organic soil, mainly peat is highly compressible and has low shear strength. To overcome the problems in the construction of infrastructures, one way to stabilize the peat soil or a way to fasten the decomposition of the soil must be investigated. The present study deals with two organic soil samples collected from different location of Sarawak (i.e., Matang and Asajaya), to investigate the effects of different types of admixtures (i.e., cement, fly ash, and lime) at various percentages and curing period to the stabilization of the organic soil. The unconfined compressive strength (UCS) test results shows that with the increase of percentages of stabilizer added and increase of curing period, the strength of the organic or peat soil sample increases.

ABSTRAK

Tanah organik, terutamanya gambut menjadi masalah utama dalam pembangunan insfrastruktur di kawasan pesisiran pantai, contohnya seperti di Sarawak, Malaysia. Dalam usaha untuk membawa kemajuan ke kawasan pesisiran pantai di Sarawak, satu sistem infrastruktur yang baik adalah perlu untuk melaksanakan program pembangunan di kawasan tersebut. Pembinaan infrastruktur di kawasan pesisiran pantai adalah sukar memandangkan kawasan tersebut dilitupi tanah organik terutamanya gambut. Struktur tanah organik terutamanya gambut adalah sangat mampat dan mempunyai kekuatan regangan yang rendah. Bagi mengatasi masalah tanah organik dan gambut dalam pembinaan infrastruktur, adalah perlu untuk mengetahui satu cara menstabilkan atau mempercepatkan proses pereputan atau penguraian bahan organik tanah tersebut. Kajian ini melibatkan dua sampel tanah organik yang diambil dari dua kawasan berbeza di Sarawak (iaitu; Matang, dan Asajaya), bagi mengkaji kesan penstabilan tanah organik dengan menggunakan pelbagai jenis penstabil yang berbeza (iaitu; simen, abu buangan kilang, dan batu kapur) pada kadar peratusan dan masa pemulihan yang pelbagai. Keputusan ujian *Unconfined Compressive Strength (UCS)* yang telah dijalankan menunjukkan bahawa kekuatan tanah organik tersebut mengalami peningkatan, dengan peningkatan masa pemulihan dan kadar peratusan penstabil yang ditambah kepada sampel.

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%	-	Percentage
&	-	and
µm	-	micrometer
AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society for Testing and Materials
BS	-	British standard
CBR	-	California Bearing Ratio
c_v	-	Coefficient of consolidation
DJM	-	Dry Jet Mixing
FWD	-	Falling Weight Deflectometer
G	-	Specific Gravity
gm	-	gram
ICL	-	Initial Consumption Of Lime Test
kPa	-	kilo Pascal
LFC	-	Lime Fixation Capacity
LL	-	Liquid Limit
LOI	-	Loss On Ignition
MDD	-	Maximum Dry Density
MPa	-	Mega Pascal
M_r	-	Resilient modulus
OC	-	Organic Content

OMC	-	Optimum Moisture Content
PI	-	Plasticity Index
psi	-	pound per square inch
PVC	-	Poly Vinyl Chloride
q_u	-	Unconfined Compressive strengths
rpm	-	revolution per minute
SEM	-	Scanning Electron Micrograph
SSG	-	Soil Stiffness Gauge
UCS	-	Unconfined Compressive Strength
vs	-	versus
XRD	-	X-ray diffraction

LIST OF NOTATIONS

w	-	water content
W_w	-	weight of water
W_s	-	weight of dry soil
M_s	-	mass of soil
ρ_w	-	density of water
V_s	-	volume of soil
N	-	Loss on Ignition
H	-	Organic Content
C	-	Correction factor
γ_d	-	dry unit weight
γ	-	bulk unit weight

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CHAPTER 1

INTRODUCTION

1.1 General

In general, soil is referred by civil engineer as the upper layer of the Earth's crust subject to weathering; it embodies rock, semi-rock and loose rock materials. Soil can also be defined as an un-cemented aggregate of mineral grains and decayed organic matter (solid particles) with liquid and gas in the empty spaces between the solid particles. Soil can be divided into two general groups; mineral soil and organic soil. Sand, silt, and clay are the examples of mineral soil. Organic soil is a non-homogeneous soil that have been generated as an outcome of decomposition of organic matter such as plant remains, leafs, and trunks. Peat soil is an example of organic soil. The organic soil having more than 75% organic matter is called peat. Peat refers to soft, wet, superficial and unconsolidated deposit with high organic materials from decayed plants. With water content up to 700%, peat soil is a very soft soil. It is formed when the organic material, e.g., from plants, accumulated much more rapidly than the humification process. This

condition is commonly found when organic materials are being preserved under a high water table like in the wetlands. Peat also posses a variability in material properties that changes chemically and biologically with time. Further humification of the organic constituents can alter the soil mechanical properties such as compressibility; shear strength, and hydraulic conductivity. Lowering of ground water may cause shrinking and oxidation of peat leading to humification with consequent increase in permeability and compressibility.

Soil improvement is needed to avoid the instability and settlement problems that always occur during the construction of the peat soils. Stabilization of soil is a way to increase the strength and stability of soil. Stabilization incorporates the various methods employed for modifying the properties of soil to improve its engineering performance. Methods of stabilization may be grouped under two main types; modification or improvement of a soil property of the existing soil without any admixture and modification of the properties with the help of admixtures. Compaction and drainage are the examples for modification or improvement of a soil property of the existing soil without any admixture. Stabilization with cement, lime, bitumen and chemical are the examples for modification of the soil properties with the help of admixtures.

There are a few methods commonly used in infrastructural construction on peat predominant areas. These are excavation and replacement method, surface reinforcement and preloading, vertical drains, piled supports and lightweight fill etc. The preference of construction method in peat and organic soil deposit areas

depend on the matter of working out the best solutions that would consider economic and technical factors, available during the construction time, and the targeted performance standards. The traditional solution is deep stabilization of the soil. However, the peat is often overlaid by loose layers of mud in which it is difficult to achieve adequate bearing capacity by deep mixing. Nowadays, in order to solve the unstable ground for construction problems, many construction companies use the oldest and simplest method i.e., excavation and replacement method; where soil is simply excavated and replaced. The excavation and replacement method is suitable for peat that is with depth of less than six meter. In the process that peat will be excavated and replaced with stable fill like sands. However, the method is expensive and frequently also problematic, as the replaced material must be disposed of and new filling material must hauled to the site. There has therefore been a need to develop a functional, economical, and more environmentally friendly method for stabilizing mud and peat. The recently developed soil stabilization technique by adding admixtures meets these requirements.

1.2 Statement of the problem

Sarawak is one of the fastest developing states in Malaysia that has shown a tremendous economic growth and infrastructural expansion, bracing itself towards a developed State status by the year 2020. With a population that is slightly over two million dispersed over a land size almost an equivalent to Peninsular Malaysia, developing Sarawak into what it is today is indeed an exceptional achievement. A

large percentage of the population however, is located along the coastal areas and towns where the primary mode of communication and transport between them and the major urban centers is by sea and river, which is greatly subjected to various weather conditions. The peat soil deposit is covering some 13 percent (16,500 km^2) of Sarawak land mass, making in the largest peat deposit in Malaysia and they occur either as basin peat that lies at the lower stretches of the coastal areas or as valley peat that can be found as small deposit in poorly drained interior valleys. As the corridors of peat deposit cover the coastal areas; it is not an easy task to build good network of transportation and communication along the coastal areas because peat soils are highly compressible and has low shear strength (Acuk, 2002).

The study on organic soil stabilization by different types of admixtures seems to be limited; therefore, an attempt has been made in this study to stabilize the organic and peat soil and to serve as a guide and trial planning for the further development of mass stabilization.

This study concentrates on the stabilization of the organic soil with the help of different types of admixtures i.e., cement, fly ash, and lime. Organic soil samples from several locations in Sarawak have been collected and then several laboratory tests have been conducted to characterized the organic or peat soil. The tests determine the percentage of moisture content, the specific gravity, the particle size distribution, LOI (Loss On Ignition), the organic content, the fiber